



ST. PAUL'S, FROM THE ROOF OF ST. BARTHOLOMEW'S HOSPITAL.

THE PRESENT CONDITION OF ST. PAUL'S CATHEDRAL.

By MERVYN MACARTNEY [*F.*], Surveyor of the Fabric.

Read before the Royal Institute of British Architects, Monday, 18th November 1907.

MY position to-night is not without its embarrassments. "The present condition of St. Paul's Cathedral," of which I am to tell you, is a subject which has of late been much canvassed, and one which I myself have examined from several points of view. But the occasions when I may becomingly break the silence which, as Surveyor of the Fabric, I have to maintain are few; indeed, I might say that a gathering of architects, meeting under the auspices of the Institute, is the only exception which I could make.

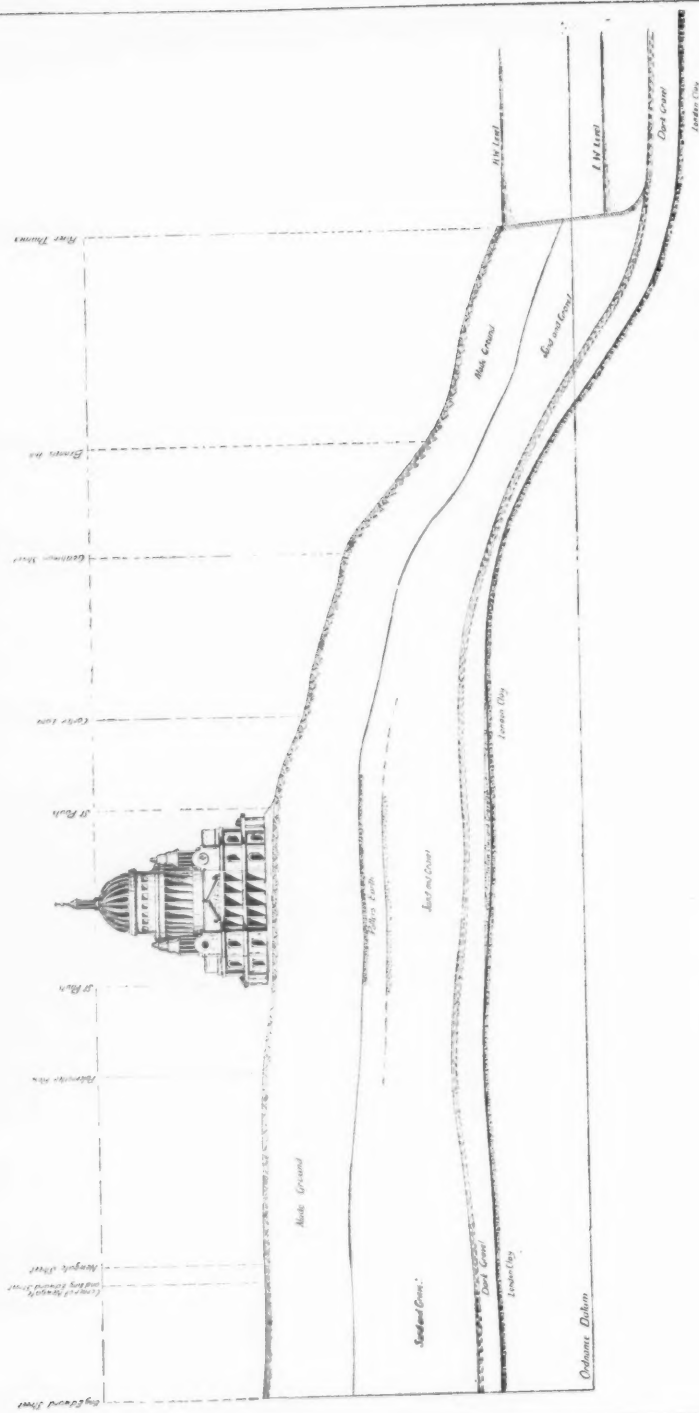
If I am to interest you in the present state of the Cathedral, I must of necessity take you back with me to survey briefly the conditions under which it was built, and the conditions in which it survives to-day. This is a matter which has been very thoroughly investigated by the Committee appointed by the Dean and Chapter, whose Report, published two months ago, is probably familiar to all. As one of the signatories of that Report, and speaking in the presence of those architects who share with me the responsibility for its production, you will understand that I am not here to offer criticism on it or to defend it. I shall take it as "the latest word" on the subject we are considering, and, without in any way impugning its completeness, I may be able, by interleaving it and by expanding some of its clauses, to follow a little further some of the subjects it suggests, but which in the Report a need for conciseness has curtailed.

The Committee open their Report with a rehearsal of the terms of their appointment, viz. to examine and report upon:—

- (1) The stability of the whole structure of the Cathedral.

ST PAUL'S CATHEDRAL.

Approximate scale { Vertical, 1 inch = 30 feet.
Horizontal, 1 inch = 265 feet.



Messrs. Barry and Lølle, Engineers.

- (2) The extent to which the stability has been, or is likely to be, affected by any alterations or disturbances in the foundations of the Cathedral, or in the soil in its neighbourhood.
- (3) The measures which ought to be taken to remedy such defects or guard against such dangers as may be discovered.

May I, then, say something of the circumstances by which those terms were dictated?

Mr. Somers Clarke, who succeeded Mr. Penrose as Surveyor of the Fabric, had recently resigned his position. During the nine years he held it he had done something towards a survey of the building, by observation, by photography, and by delicately adjusted apparatus, with a view to discovering its stability amid modern conditions.

The results of his inquiries, given to the Dean and Chapter in his Annual Reports, were sufficient to convince them that there were weaknesses in the structure which the continued invasion of the subsoil on all sides might speedily endanger. Of one such inroad the authorities had become aware shortly before my appointment a year ago. I refer, of course, to the low-level sewer proposed along the south side of the Churchyard. This, in the light of what they had been learning from their Surveyor, they not unnaturally viewed with alarm, and the opportunity seemed a good one to inquire, not only into the probable effect on the Cathedral, but into the general condition of the fabric itself—to take stock, so to speak, and to obtain the best procurable advice.

It was decided, therefore, on 6th December last that such advice should be sought, and certain architects were invited to act with myself in the matter, the choice falling, as you know, on the President (Mr. Colcutt), Sir Aston Webb, and Mr. Belcher, who readily consented to devote their time and abilities to so serious a task.

While setting to work systematically on the history of the Cathedral's building and the question of its soundness, we had to bear in mind the very pressing danger, as we thought it, of the London County Council sewer, and as soon as our researches had been carried far enough an Interim Report was drawn up and presented to the Chapter. The need of haste in this matter is, I think, amply proved by the fact that on 12th March we learned that the contract for constructing the sewer was let and £100,000 worth of plant and material ordered. Four days afterwards our Report was signed.

After referring to the weak places in the Cathedral, among them the south-west tower, we said:—

“That while it was contended by very eminent engineers that if the sewer were constructed in the clay with a shield and protected by proper precautions no harm could come to the Cathedral, we, on the other hand, felt compelled to come to a different conclusion.

“Bearing in mind the difficulty, if not impossibility, of complete and adequate supervision of a work of this character, and the disturbance that had undoubtedly been caused to surrounding buildings by similar works in London, we were of opinion that the construction of such a sewer so near St. Paul's, taking into consideration the sensitive condition of the structure, would very possibly become a serious danger to the Cathedral fabric, and should therefore be opposed by the authorities by every means in their power in order to secure another route for that sewer which would be free from any possible risk to the building.”

What followed is well known to you in the words of the Report. We were gratified to learn that this Report was adopted, and that the London County Council, after due consideration, had agreed upon another route. By this decision we were of opinion that great danger to the Cathedral had been averted.*

* The new route follows Upper Thames Street.

I have expanded this reference to the Interim Report and quoted from it because it explains the immediate reason of the Committee's appointment, and also because without it a casual reader might think that the question of the sewer had been ignored or insufficiently mooted. The Report proceeds:—

“During the course of our inquiries we have had access to documents containing much matter of interest of which we have been glad to avail ourselves. We gather from these and from other sources that the nature of the subsoil on which the present Cathedral is built was from the first a matter of the gravest concern, and that Sir Christopher Wren was much impressed by the seriousness of the problem of obtaining suitable foundations for his church.”

It would take too long to discuss or quote at length from all the documents here referred to; a large amount of information was gathered and brought before us, records in the Cathedral and other libraries were searched, Wren's own drawings and methods carefully examined and considered.

Anything of the nature of an historical account of the inception of Wren's Cathedral—except so far as it bore directly on the question at stake—has been avoided in the Report; but before I go further I may be allowed to remind you of some of the more important facts. Sir Christopher Wren first comes on our scene in the days of Old St. Paul's, which stood in 1660, saving the loss of its spire and the addition of Jones's portico, pretty much as it had for nearly three centuries. Wren designed to remodel the central feature, replacing the tower by a dome surmounted by a lofty cupola, and ingeniously masking the Norman nave both within and without with a veneer of approved classic ornament agreeable with the prevailing taste. Some drawings in the Library of All Souls' College, Oxford, afford us an idea of this. They bear date 1666, and there can be no doubt that they represent the scheme which was in contemplation just before the Fire of London.

The great catastrophe was followed by a period of chaos, at St. Paul's as elsewhere, from which order was but slowly evolved.

Properly enough, and quite in the spirit of the olden Churchmen, it was at once resolved to make temporary provision for the Cathedral services. In the words of Dugdale, “The first thing designed after this deplorable fire was to fit some part of the Church for a quire, to which end it was resolved that part of the body of it, towards the west end, might be made useful for that purpose, in which work no less than two years were spent. Towards the latter end of 1668, it was concluded that the foundations [*i.e.* the remaining walls] of the Old Cathedral thus made ruinous should be totally cleared; and preparation of material and all things needful made ready conducing to a new fabrick, which work continued until the last of April 1674,” at a cost of nearly £11,000.

Meanwhile Wren had been commissioned to build the new church, and more than one design, to say nothing of minor variations, was prepared and abandoned. Letters patent for what is known as the “Model” design [fig. 2] and Wren's favourite were granted in November 1673, and when this was rejected by the ecclesiastics on the score of an unsuitable ground plan, another scheme was projected. Some drawings with the warrant for the rebuilding and sealed with the King's Privy Seal are also at All Souls; and though this is called “the approved design,” the Royal approval seems to have had little real effect.

This was followed by the design which finally triumphed, in the foundations of which Wren exercised so great care. In his endeavour to “build for eternity,” by deflecting the axis of the church slightly to the north-east [fig. 3], he skilfully avoided the foundations of the former church, which he decided not to use, “fearing the old and new would not stand together without cracks.” To this all-sufficient reason may be added two others of some weight. In the first place the Act of Parliament for the rebuilding of the city laid down



FIG. 2.—WREN'S "MODEL" DESIGN. FROM THE MODEL PRESERVED IN ST. PAUL'S.

forty feet as the width of the main streets—of which that on the south of the church was one—while on the north side was the Churchyard and greater freedom. And by adopting this course Wren was released from the strict lines of the mediæval plan and found room for the foundations of the great dome which he had all along intended as the central feature of the Cathedral.

He therefore rejected the old footings and turned his attention to providing new ones. Here I may quote at length the passage in *Parentalia*, from which only extracts are given in the Report:—

“The Surveyor observed that the foundation of the old church stood upon a layer of very close and hard pot-earth, and concluded that the same ground which had borne so weighty a building might reasonably be trusted again. However, he had the curiosity to search further, and accordingly dug wells in several places, and discovered the hard pot-earth to be on the north side of the Churchyard, about six foot thick and more, but thinner and thinner toward the south, till it was upon the declining of the hill scarce four feet.

“Still he searched lower, and found nothing but dry sand, mixed sometimes unequally but loose, so that it would run through the fingers. He went on till he came to water and sand mixed with periwinkles and other sea-shells; * these were about the level of low-water mark. He continued boring till he came to hard beach, and still under that till he came to

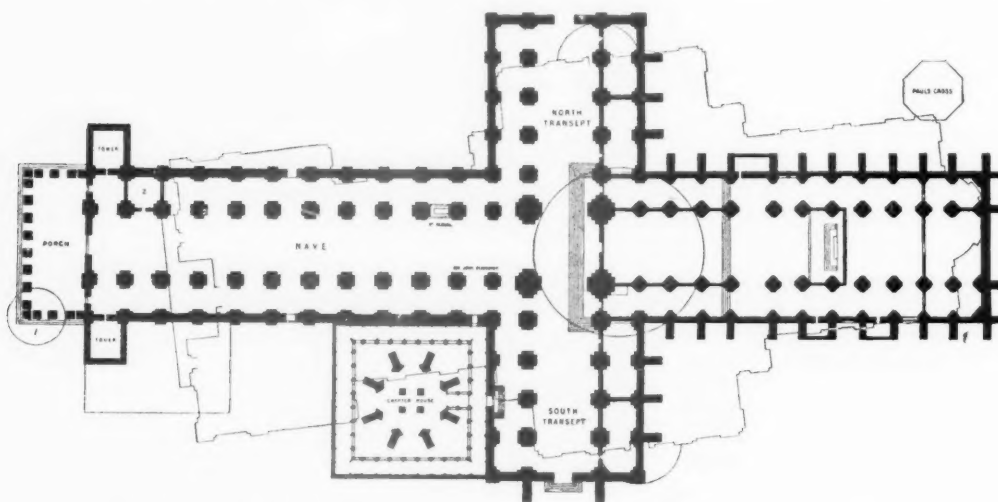


FIG. 3.—GROUND PLAN OF OLD ST. PAUL'S, SHOWING IN OUTLINE THE CHANGE OF AXIS IN THE PRESENT CATHEDRAL.

the natural hard clay which lies under the City, and country and Thames also, far and wide. . . . In the progress of the work of the foundation the Surveyor met with one unexpected difficulty; he began to lay the foundation from the west end, and had proceeded successfully through the dome to the east end, where the brick-earth bottom was yet very good; but as he went on to the north-east corner, which was the last, and when nothing was expected to interrupt, he fell, in prosecuting the design, upon a pit where all the pot-earth had been robbed by the potters of old time. . . . It was no little perplexity to fall into this pit at last; he wanted but six or seven feet to compleat the design, and this fell in the very angle north-east, he knowing very well that under the layer of pot-earth there was no other good ground to be found till he came to the low-water mark of the Thames at least forty feet lower. His artificers proposed to him to pile, which he refused. . . . He therefore sank a pit of about eighteen feet square, wharfing up the sand with timber till he came forty feet

* Freshwater univalves really.

lower, with water and sea-shells, where there was a firm sea-beach. . . . He bored through the beach till he came to the original clay; being then satisfied, he began from the beach a square peer of solid good masonry, ten feet square, till he came within fifteen feet of the present ground; then he turned a short arch underground to the former foundations which were broken off by the untoward accident of the pilt. Thus this north-east coin of the quire stands very firm, and, no doubt, will stand."

In carrying on the work "the greatest care and industry was used, so that by the beginning of April anno 1685 the walls of the quire with the side isles thereto containing one hundred and seventy feet and in breadth one hundred and twenty foot, with the great arched vaults underneath, were finished. As also two stately porticoes North and South opposite to each other and the huge and massive pillars of the Dome (which is one hundred and eight foot in diameter within the walls) brought to the same height, the work being totally wrought of large Portland stone."*

The west end of the old church was not entirely taken down until 1686.

Contracts for timber for covering the aisles of the new choir were signed in June 1688, but it was not until 2nd December 1697 that the choir was formally dedicated, the occasion being the thanksgiving for the Peace of Ryswick. The morning-prayer chapel, the present St. Dunstan's Chapel, was completed in 1698-99, which would seem to imply that the work at the west end was then nearly finished. The topmost stone of the dome was laid in 1710, the date usually taken as marking the completion of the building, though much work was still going on within and without, and much was left undone.

But before this date, in December 1709, an entry in the Cathedral pay-book records "work done in repairing flaws occasioned by y^e pressure, making good such stones as could be left remaining with lead and plaister being the eight Leggs of the Dome and in the inside of the East, W., N., and South cross being above 1,500 foot in periphery." This repairing continues in the two months following. Similar entries are found during the first six months of 1716, where one of the legs of the dome is mentioned as having been repaired with "42 tun of Portland stone," and again in 1722, when repairs to the south-east leg of the dome are specified. One of Wren's original drawings in the Cathedral library is a quarter-plan of the dome area on which the great south-east pier is noted as "the peer which has been repaired" [fig. 4], and the work was done by Edward Strong, who succeeded his father and uncle as clerk of works. From Clutterbuck's *History of Hertfordshire* we learn of Edward Strong that he "also repaired all the blemishes and fractures in the several legs and arches of the Dome, occasioned by the great weight of the said Dome pressing upon the foundations; the earth under the same being of an unequal temper, the loamy part thereof gave more way to the great weights than that which was gravel, so that the south-west quarter of the Dome and the six smaller legs of the other quarter of the Dome, having less superficies, sunk into the thinner part of the loamy ground, an inch in some places, in others two inches, and in othes places something more; and the other quarters of the Dome being on the thicker part of the loamy ground and gravel, it did not give so much way to the great weight as the other did, which occasioned the fractures and blemishes in the several arches and legs of the Dome."

From the date of the completion of the shell of the building we have no evidence of any anxiety for the building's safety for over a century. The pay-books record nothing beyond the ordinary repairs; the disputes about the balustrade above the cornice and as to the position and height of the inclosing rails waxed and waned, and not until 1831 is any note of alarm sounded.

* Ellis's edition of Dugdale, page 140.

At that time there was much constructing and remaking of sewers in the metropolis, and one was schemed to go round the south side of the church from Ludgate Hill to Cannon Street.

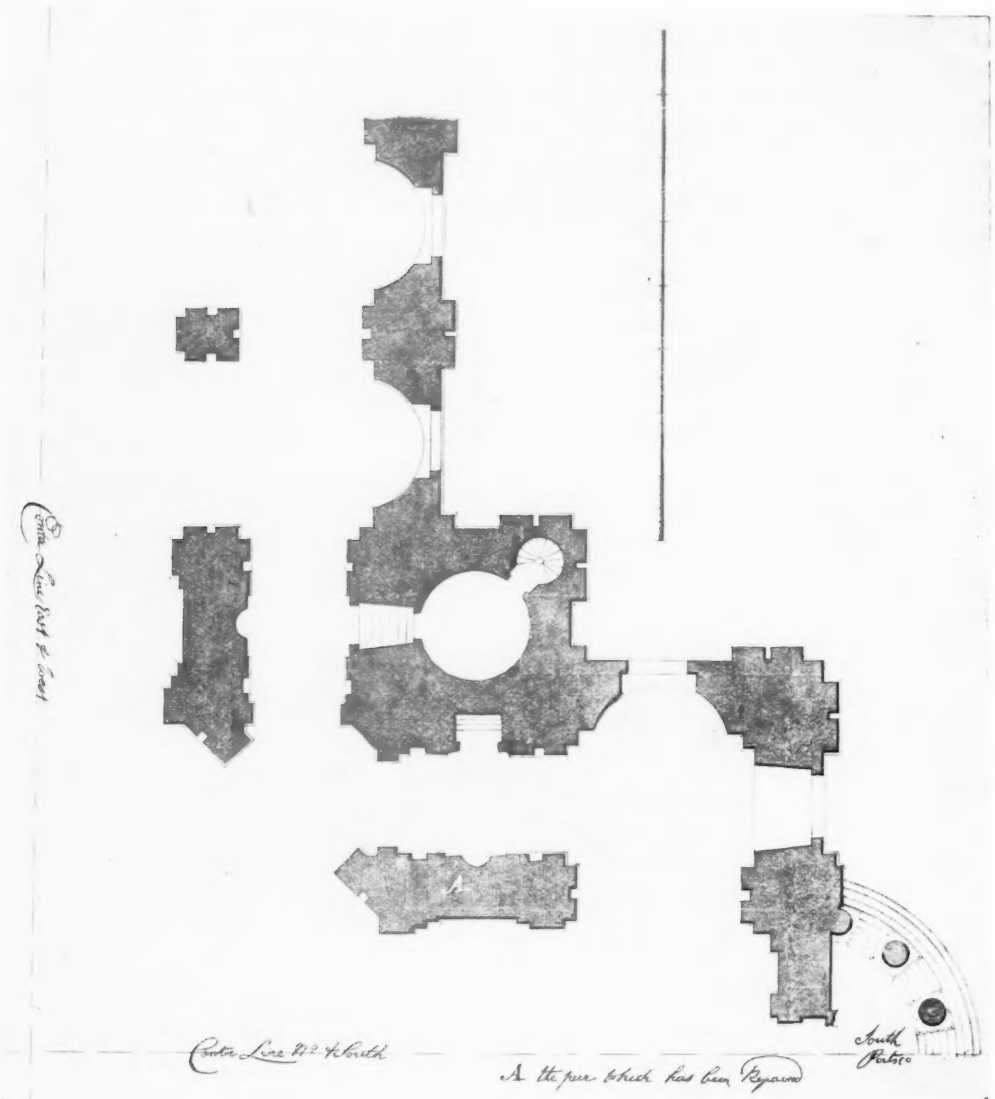


FIG. 4.—FROM THE ORIGINAL DRAWING BY SIR CHRISTOPHER WREN, IN THE LIBRARY OF ST. PAUL'S.

Mr. Cockerell, the Cathedral Surveyor, drew the attention of the authorities to the danger, and, together with Messrs. Robert Smirke and George Rennie, drew up the Report, which we put in in full.

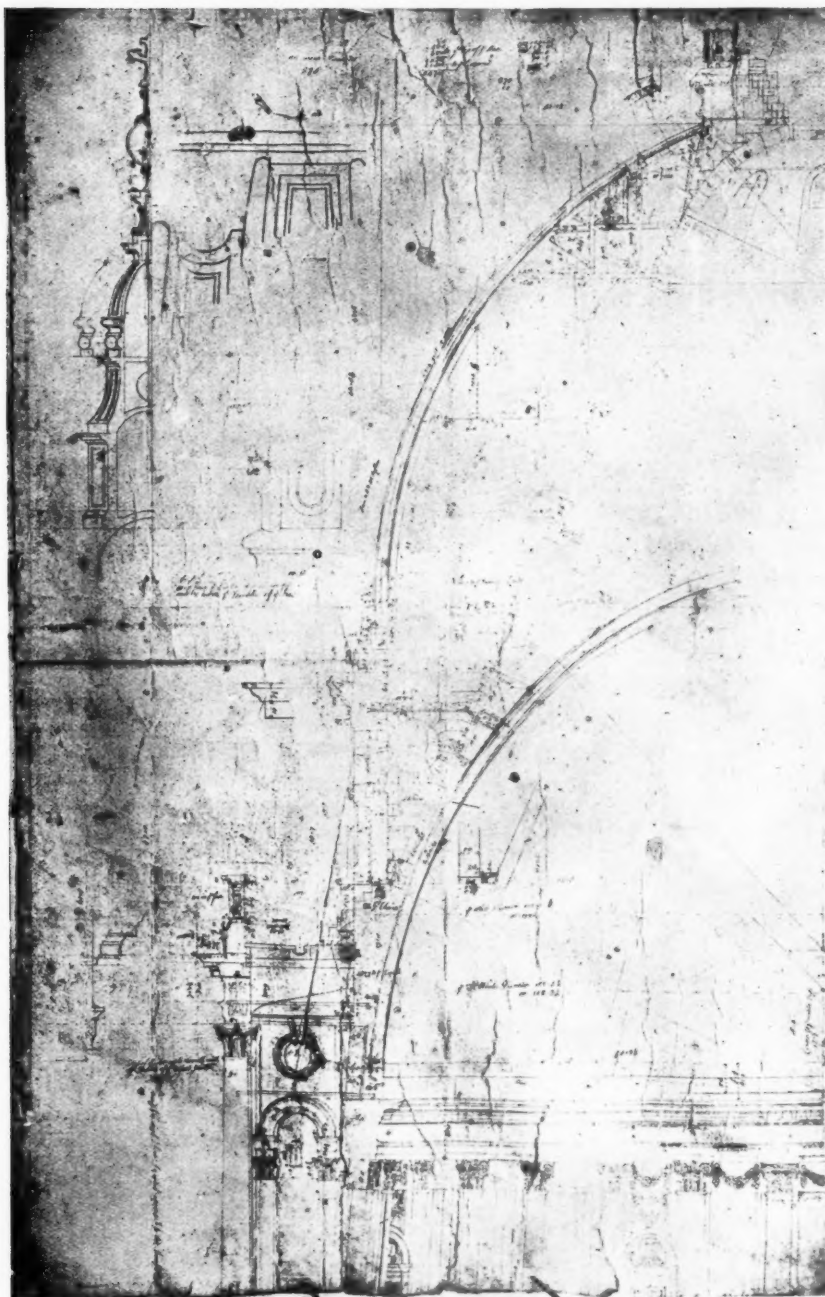


FIG. 5.—FROM THE ORIGINAL DRAWING BY SIR CHRISTOPHER WREN, IN THE LIBRARY OF ST. PAUL'S.

"We, the undersigned, having by direction of the Dean and Chapter of St. Paul's Cathedral examined and considered the situation in which the Commissioners of the Sewers have begun to construct a sewer on the south side of the Cathedral, and considering that the footings of the walls rest chiefly upon a thin bed of pot-earth, beneath which is a very deep stratum of sand and gravel containing a considerable quantity of water, and that the walls of the south transept have sunk and are fractured, apparently by reason of some partial weakness in this part of the foundations, are of opinion that the security of the fabric will be endangered if the sewer is constructed in the Churchyard.

"We are likewise of opinion that, however carefully the work may be constructed, it will be impossible to prevent some degree of motion from taking place in the said stratum of sand and gravel either during the construction of the sewer or at a future period in consequence of it; and we therefore earnestly recommend that the Commissioners should be requested to abandon this line for their sewage, and remove it to such a distance as will prevent all risk of injury to the perfect security of the Cathedral."

The circumstances were in some respects parallel with those of our day, and the correspondence which passed between the early Committee leaves no doubt in the mind that they felt very seriously the danger, and took especial pains to use no ambiguous phrases in wording their protest.

"Wintershall: 27th August 1831.

"MY DEAR ROBERT,—I found your letters of the 22nd and 25th on my arrival here from Plymouth and Portsmouth, &c., last night, and although I have not considered the question of the sewer and St. Paul's foundations about to be propounded to me, I think you were quite justified in protesting against the making of the said sewer so near as 50 feet from the foundations of St. Paul's. From repeated experiments with a klinometer, that is, an instrument for ascertaining the slopes or angles of equilibrium at which earth, sand, &c., stand, I have found that the average angle of dry sand is 44 degrees; of moist sand is 35 degrees; of quicksand is 10 degrees; so that, taking dry sand and the slope at a horizontal distance of 50 feet, and vertical depth of 25, the slope would extend to the sewer, and in moist and wet sand would enter at 35 degrees, or nearly 3 to 1; 10 degrees, or nearly 12 to 1; that is, far beyond the centre of the sewer, and of course dangerous to the stability of St. Paul's. This is what I should call the scientific way of viewing the question, although that word is (I am sorry to say) dreadfully abused at times. But I shall be in town on Monday at 6 o'clock; I will either see you on that night or on Tuesday morning. . . .—Believe me to remain very truly yours,

"GEORGE RENNIE.

"C. R. COCKERELL, Esq."

"Friday morning.

"MY DEAR COCKERELL,—I send a sketch of the sort of Report which I should prefer signing with you and Rennie. And I think you will both agree with me that, whatever modification this may require, it is at least indispensable that our opinion should be expressed in a clearer and more decided manner than in that proposed by Acton. I cannot think it sufficient to say no more than 'there is a possibility' that 'some degree of motion might take place now or at some remote period,' &c. Nor can I understand what is meant by the opinion that this line of sewage 'however eligible in other respects,' for I know of none at all to make it eligible, and certainly none are stated in the Report. Nor would I propose that the sewer should be removed to 'such a distance from the fabric as will in the judgment' of the Commissioners, &c. . . . for it seems rather a laughable sort of compliment to say this after declaring that in our opinion they have had so little judgment.—Yours very truly,

"ROBERT SMIRKE."

The result was that the Commissioners of Sewers consented to divert the sewer along Carter Lane, where it was considered it would not in any way affect the foundations of the church. From this time onwards the series of Surveyors' Reports is fairly regular, though there are some years missing. The constant small repairs recommended for the fabric are almost all noted as due to the iron cramps used so largely and insufficiently imbedded in the stone, and frequently this phrase or a similar one occurs. In no case do they suggest any cause for anxiety for the condition of the structure in general. About 1850 some settlement appears to have been noted, but we may judge that it was slight, for in 1853 there were no further movements to record, and the use of a coloured cement in stopping the cracks in the masonry so as to facilitate recognition was postponed as of lesser importance than other work about the building, and was not completed until 1856. No further note of alarm as to the Cathedral's safety was sounded until the preparation of the Central London Railway Bill in 1890.

In November of that year Mr. Penrose reported as follows:—"During the late parliamentary session a matter arose which there was reason to apprehend might have seriously endangered the fabric, namely, the proposed Central London Railway, of which the proposed line was in a tunnel running the length of Newgate Street, at a depth of more than seventy feet below the floor of the church. As there is great probability that a tunnel so placed at a depth of more than seventy feet below the floor of the church would drain off the water from the lower strata of the gravel and sand which underlie the foundations of the Cathedral, and so cause them, to some extent, to collapse, there would be great risk of serious injury to the structure. This scheme passed a Committee of the House of Commons, but was thrown out by the Committee of the other House, not indeed without cost to the Dean and Chapter, but it appears to be a great danger averted."

In his evidence supporting the petition lodged by the Dean and Chapter against the Bill, Mr. Penrose said:—"The danger to the structure of St. Paul's Cathedral if the proposed works are carried out exists chiefly on account of the sandy nature of the strata upon which the foundations stand. These foundations are laid on a comparatively thin bed of marl, below which there exists more than forty feet of loose sand and gravel. It must also be remembered that St. Paul's Cathedral is erected on the top of a considerable hill. If the water which is mixed with these strata was withdrawn, the result might, in my opinion, be exceedingly serious, as this must cause a very considerable collapse in the strata itself . . . in the excavations which must take place for the purpose of the proposed railway tunnel, and more especially in the large excavation which would be required for the intended station between Newgate Street and the Cathedral, at the depth proposed, which is some sixty feet below the present surface, there would be very great risk of interfering with these strata, and if this excavation should, as in all probability it must, take place irregularly over the section of the works within the immediate proximity of St. Paul's, the danger would be very considerably increased."

This brings us down to comparatively recent history, and it may be convenient at this point to proceed on a rather different method.

The main points of weakness in the Cathedral—the parts, that is to say, which have shown, and on the slightest disturbance will show again, signs of settlement and movement—are the dome, the south transept, and the western towers and portico.

The Dome.—This has been referred to earlier as having been repaired during the building, when the south-east pier sank owing to the inequality of the subsoil. In 1878 the dome was measured, and it was found that while there are signs of a very measurable amount of subsidence and disturbance of level having taken place in the structure, yet that



FIG. 6.—ST. PAUL'S: VIEW FROM THE NORTH-WEST.
Re-faced from Birch's *London Churches*, by kind permission of Mr. Batsford.



FIG. 7.—ST. PAUL'S CATHEDRAL: PART OF SOUTH FRONT.
Reprinted from Birch's *London Churches*, by kind permission of Mr. Batsford.



FIG. 8.—ST. PAUL'S CATHEDRAL: THE NORTH TRANSEPT.
Reduced from Birch's *London Churches*, by kind permission of Mr. Batsford.



FIG. 9.—ST. PAUL'S CATHEDRAL: THE BISHOP'S THRONE.
Reduced from Birch's *London Churches*, by kind permission of Mr. Batsford.

a very large part of this had already occurred during the progress of the work, and that some of the courses of stone-work, especially those immediately above the dome cornice, are thinner considerably in one direction, so as to compensate for what had then occurred, and to bring the upper part of the structure again level. This shows that such movements as have more recently occurred are very much less in amount than they otherwise might be supposed to be. It was found in 1884 that this compensation occurs in the cupola itself.

The settlement of the dome shows that, in spite of the care with which Wren spread the weight, the centre of the great mass has sunk and is now severed from the surrounding masses.

The dome is carried on eight great piers about thirty feet long: these at the crypt are connected with the bastion-like masses at the angles of transepts with nave and choir by long barrel vaults: these are in every case cracked through. These bastions, were they solid, might easily have contributed to the sinking of the dome, but in fact they are admirably contrived for their purpose as counterweights, and being much hollowed for staircases, vestries, and the like.

The weight of the superstructure rests much more on the inner ends of these eight piers than on the outer ends, in spite of Wren's devices to distribute the weight, and the sinking of these piers has set up movements overhead. Moreover, these great piers have not sunk equally, those on the south side connecting with the south transept being lower than the others; and of these the westernmost has descended bodily over six inches.

This may be seen in a striking degree in the colonnade round the drum of the dome. These columns are in reality the outer ends of a series of arches set at right angles to the thrust of the base of the cone. These arches and the roundels above them are all more or less cracked, and the colonnade is practically severed from that part of the arch which abuts on the dome. The dislocation is sometimes very great. This downward tendency of the central mass of the dome may be illustrated further from the clerestory windows which adjoin it and from the triforium arches in the transepts. Between the south or end wall of the south transept and the pier which carries the dome, the great arch into the aisle and the clerestory wall above are broken through. In a less degree, according to the subsidence of the mass of the dome, this occurs in connection with each dome pier.

When the west window of the south transept was repaired in 1891 Mr. Penrose referred to it as having been much dislocated by a settlement of old standing, of which happily there seems to have been no recent recurrence.

The south transept has suffered, in addition to the dislocation of the parts abutting on the dome, by the tendency of the south front of it to move outwards.

The portico was much repaired in 1890, the stonework having suffered to a very great degree from the oxidisation of the iron cramps; among other things the whole of the frieze was taken down piece by piece and replaced and in many places renewed.

The walls of the southern façade have moved outwards, and have sunk slightly to the east and west: this showed itself in the south window arch and in the upper part of the transept. In 1897 it was noted that the window arch was resting on and had actually bent the iron stanchions which were intended merely to stiffen the lead glazing, and that the glazing itself had been crumpled. To remedy this a steel frame for the window was inserted at the time when the new glass was put in, a similar precaution being adopted in the north transept, where the same had happened, though not so badly. Early in the last century strong iron rods had been inserted longitudinally below the window in the south transept, as well as in the direction of the dome, and these it was found necessary to augment in 1898, when additional tie-rods were inserted above the window and at the roof level, and anchored back into the

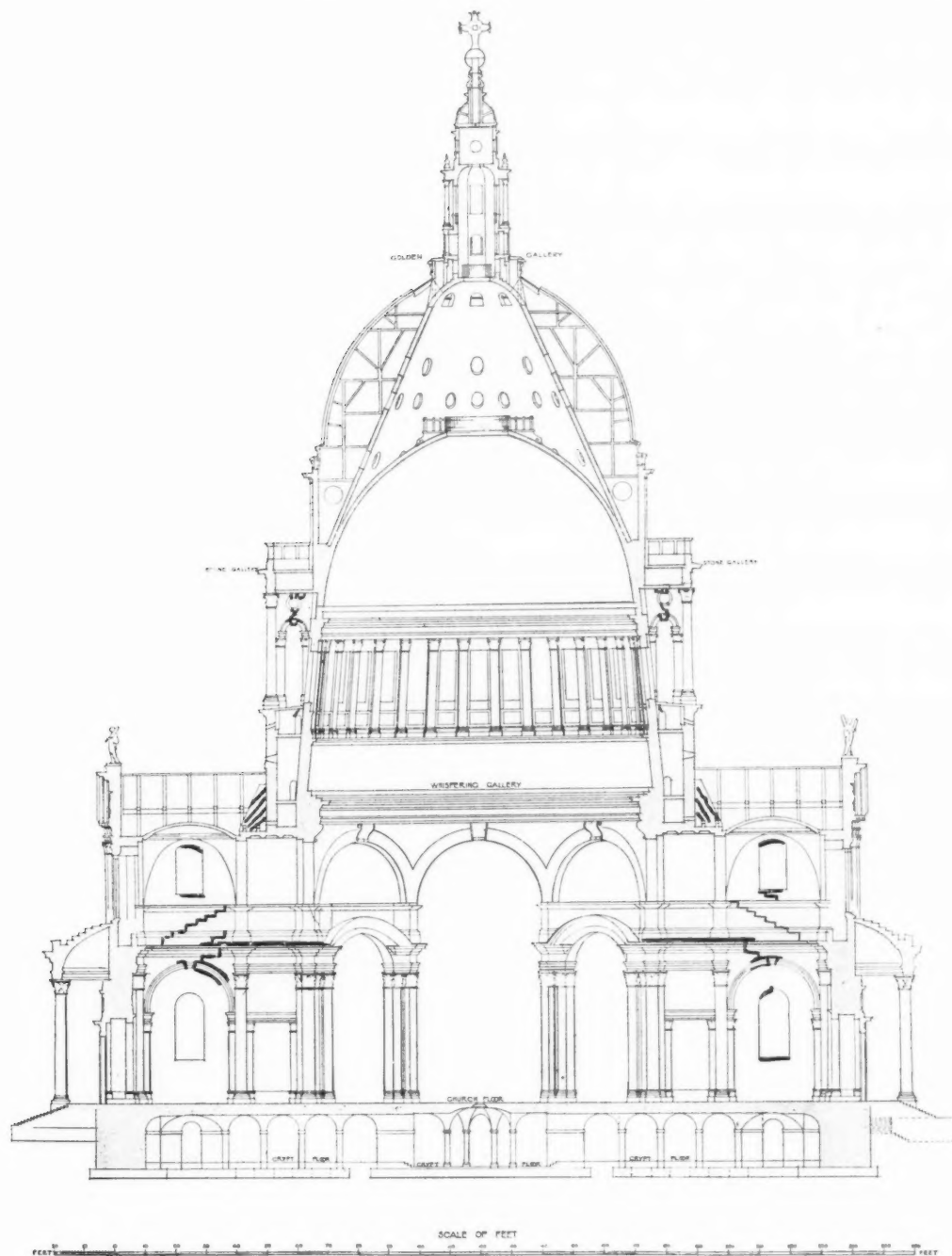


FIG. 10.—CROSS-SECTION THROUGH TRANSEPTS SHOWING CRACKS.

masonry as near the great piers of the dome as could be contrived, as the wall then still showed a tendency to advance southward. But my predecessor, who was satisfied as to the efficacy of these rods for all ordinary purposes, took care to add, in 1901, that the system of tie-rods was not undertaken at a time when the fabric was threatened with the very near approach of the proposed electric railways, and could not be considered as sufficient against so great a danger.

Coming to the west front we find two tendencies at work, the one arising from the other: the two towers are out of the perpendicular, the one to the north and the other to the south; and the portico, which has been said to be the only flimsy piece of construction in the Cathedral, has followed the direction of the towers, and, in addition, has moved westwards.

Mr. Penrose, in his last Report as Surveyor, records that the whole of the masonry of the west portico is under repair, the chief mischief having arisen from the iron cramps, but that some injury was due to an ancient settlement.

In August 1901 the south-west tower was plumbed to a height of some one hundred and thirteen feet, and a deviation was noted which when worked out proves that the top hangs over some inches south-west, while the other tower inclines, though to a less degree, to the north-west.

The movement of the south tower has affected that part of the building east of it, and in the library, over the south-west chapel, the indications of the movement are very clearly seen. A further proof of the movement of the towers is the curved line of the granite steps, which was found necessary in order to avoid partly burying the bases of the columns of the portico.

These inclinations are sufficient in themselves to jeopardise the safety of the two wide arches of the portico between the towers. The towers actually form the abutment of these arched ceilings, which have a span of forty-eight feet, while they do not rise ten feet.

The portico consists of two stories, and the front is composed of two series of coupled columns, and is not in itself a very stable piece of construction. Instead of the spaces between them being bridged by single pieces of stone, concealed arches are made use of: at the north and south ends these arches are without any solid abutment, and yet on them rests the heavy mass of the pediment.

Then the two ranges of columns each support a cornice which projects westwards, with no similar projection to the east to counterbalance it. Above the upper cornice the cornice of the pediment and the sculpture of the tympanum also overhang.

Thus there is a height of about one hundred and twelve feet, and the shafts of the columns supporting it four feet at their thickest, with considerable voids between them.

Sir Christopher Wren was probably wise in constructing this portico as he did. The size of the stones used and the slight dependence on the west front of the church would rather increase than lessen its durability; for, being comparatively independent of the great mass behind it, it could adapt itself to any possible movement, whereas, had it been rigidly and thoroughly secured to it, it would have been liable to any of its accidents. The lower arch carries on its back the floor of the upper portico and is strengthened by it, but the upper vault of the same span has not a corresponding weight on its haunches, but depends for its rigidity on the abutment of the towers.

Considering the vastness of the latter and the lightness of the vault, only one foot six inches thick, it was not unreasonable for Wren to assume that the abutments of the vault would not spread outward.

Unfortunately the towers have moved, and when the repairs of the upper portico were begun a few years back the dislocation they had caused was found to be considerable. Some

of the stones forming the vault had sunk two inches, and at the crown of the vault the stones were nipped at the extrados instead of on the line of the intrados, as should be the case.

However, after very considerable repair and much renewal, the portico has been restored to its original state—allowing of course for the increase in its span—and, assuming that existing conditions can be maintained, may be said to be safe.

But we have learned the secret of its weakness while providing for its strength, and we see how dependent it is on the western towers, and how they in turn stand or fall by the maintenance unimpaired of the ground on which they were built.

How the ground is composed we may see from the section [fig. 1], particularly from the diagrams of the borings which were made in March last [Plate V.]. These show how the strata vary even in the length of the Cathedral, and that the water level drops two feet from the east end to the south of the south transept, and a few more inches in a westerly direction to the bore-hole east of the south-west tower. The average depth of the foundations is four feet six inches below the crypt floor, which is six feet below the ground level north and south, and the footings of the walls consist of three 12-inch courses of stone with a projection of about two feet.

In no case have these shown signs of insufficiency, nor has any organic weakness been discovered in the structure itself. Where the walls have been opened for one reason or another they have been found to be perfectly well constructed. For example, in 1889 a new staircase was made near the north-east corner from the crypt to the aisle above, and the Surveyor in his Report took occasion to remark on the extreme solidity and tenacity of the rubble core of the walling.

All observations tend to prove that the danger to the Cathedral comes from subterranean or atmospheric influences. Interference with the subsoil was clearly not contemplated by Wren, and without it we might even now reduce to a minimum the Cathedral's danger.

The action of rain and of the increasing plague of soot, smoke, and grime are of less importance, but in a building of the size of St. Paul's, with its long ranges of gutters, parapets, and cornices, they are by no means negligible.

Already the oxidisation of iron cramps has been referred to: these, wherever and whenever accessible, are replaced by copper. Where securely buried from the effects of the air the iron has been found to be as good as the day it was embedded, but near the surface it has caused much mischief. Mr. Penrose in 1888 noted the prevalence of this trouble in buildings of the period all over London, which had not till then suffered from it to any such degree before.

The smoke nuisance, though it has long been growing, is only recently become acute. The incrustations of soot and gypsum about some parts of the Cathedral are considerable, and are to be dealt with.

THE DOME OF ST. PAUL'S. By WM. DUNN [F.].

SO much has been said and written on St. Paul's dome from the general point of view that I feel I could not hope to interest you by merely adding my own views on the construction adopted by Wren.

I might have attempted what I believe has not yet been done, a mathematical investigation showing the nature, amount, and distribution of the stresses with such accuracy as could be attained in so indeterminate a structure. That would be, I think, an interesting subject, and one of considerable value to the guardians of the Cathedral and to the public, but it is more suitable for a written communication which we can read and debate at leisure than for utterance on such an occasion as this. I therefore thought it better to make a short study of some details of construction which could be explained orally and by drawings, of sufficient importance and interest to justify me in bringing them before you, and which had either not been previously mentioned or else been very little discussed. Mr. Macartney very kindly supplied me with various drawings, and with the help of his assistant, Mr. Halley, I made sketches and measurements in parts undisturbed for years back, if we may judge from the dust. From the measurements taken, plans and sections were prepared, but I thought that the relations of the whole would be better displayed in an isometrical view such as foreign students have made of St. Peter's, of the Duomo at Florence, and other domes, but which no one has undertaken, so far as I know, for St. Paul's, with the result which I have the pleasure to put before you.

It is a peculiarity in domes that, while any load affects all parts of the structure below it, it has no effect on the stresses in the parts above it. Accordingly we may properly begin our description at the top, where we would begin an investigation of its strength.

The lantern is a massive stone structure, the exterior rectangular in plan, about twenty feet over all, and about fifty feet high. The interior is an octagon shape, and the whole is surmounted by a small wooden dome on which is the ball and cross of sheet metal on very heavy wrought-iron frames.

At the top of the great outer dome and at the base of the lantern is a belt or girdle of stone, forming the apparent abutment for the top of the ribs of the outer dome, and appearing as a base for the lantern.

This girdle of stone is about ten inches in thickness and eleven feet in height. It is tied back by metal ties to the main body of the lantern: these are visible just below the stone floor of the Golden Gallery and radiate from the centre. They are about two inches by two inches in section.

All this heavy load of an irregular shape had to be supported by the apex of a hollow cone. A hollow cone is fairly stable if supporting vertical loads round its periphery such as arise from the weight of a circular drum. It is not at all a stable form under loads such as Wren had to deal with, unless these loads are converted into vertical loads uniformly distributed round its circumference, and that is what he has done.

The method adopted was to place on the cone a domed top such as we put over a well, and to use this as a foundation for the lantern. Over this domed top he distributed the weight of the lantern by buttresses, the lower parts being radial and sloping, the upper parts being vertical and at right angles to the square of the lantern and to each other. The view shows these buttresses or foundations, on which rests not only the main body of the lantern

but the stone platform of the Golden Gallery. The outer edge of the platform rests on the circular girdle or drum of stone before referred to; the bases of the buttresses and this drum must rest on stones which are part of the arch rings of the dome top of the cone, and which stones have the top beds horizontal, as in sketch, but the dust of ages and the difficulty of access prevented me from actually seeing this.

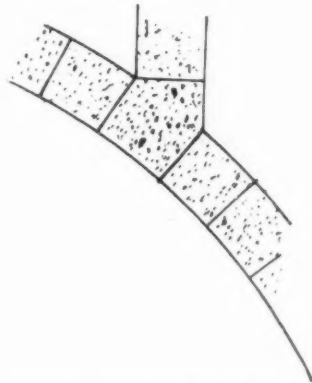
Like well tops, this domed top had also an eye or opening in the centre, so that in section the lantern seems carried on an arch without a keystone. Of course the reason why this stands is that, unlike arch stones, the stones of which it is built are subjected to pressure on all four faces, so that they cannot collapse inwards. But if the top of the cone or base of the domed top spread outwards, we should see a series of radial cracks extending from the base towards the centre, and this would lead if sufficiently extended to collapse. This spreading of the base is usually resisted in wells by the resistance of the earth. Wren supplied it by three iron ties shown on the original sections, one of which is visible crossing the openings at the apex of the cone and measured 4 inches by 1½ inch; the other two are buried in the thickness of the stone.

The positions of these three circumferential ties are well chosen. They are close together, and as the absence of radial cracks in the dome-top has shown that they are sufficient for the work, their effect is to convert the loading immediately below each point at which they occur into purely vertical loading. In an arch the thrust is constant from key to spring; in a dome the thrust is constantly increasing downwards until the inclination of the surface of the dome to the horizon exceeds a certain angle. Below that angle one of two things happens: either the material of which the dome is formed gradually takes up bit by bit this thrust, until, the dome being hemispherical, the whole thrust has been gradually overcome; or else it splits into a series of arches and the thrust remains constant at the value it has at the crown-ring of the arches. But if we mistrust the material, if we are using concrete, or stone, or brick, materials which have but small resistance to tension, and which may have even that small resistance destroyed, as in the case of concrete by shrinkage stresses, or in the case of stone or brick by unequal settlement, we may, as Wren has done, put in a series of bands of a material which will resist tension, and so have either reinforced concrete or reinforced masonry. The effect of each tie, providing it does not yield, is to convert the load on the point below it into a vertical load.

You will observe from the large section shown you that Wren has put a series of seven circumferential ties round the cone above at various points from top to bottom, with the object of making each upper section independent of the spreading of the part below from settlement or yielding of the ties. A great deal has been written about the danger of iron embedded in stone. It is a danger undoubtedly if the air is not excluded from the iron. But given unpainted iron and an impervious covering of mortar or concrete, iron does not rust, but remains bright, nay, even loses such rust as it had, and becomes bright.

You may remember that Mr. Somers Clarke had the great chain round the dome exposed, and found it quite bright and clean; that was because the air had been excluded. It is a more difficult matter to exclude it from air in 18-inch stone or brick wall, and the theory of its protection was not understood in Wren's time.

In a case in the gallery over the south aisle there are many pieces of wrought-iron



SUPPORTING STONES FOR BASE OF GIRDLER OF STONE UNDER GOLDEN GALLERY.

cramps and such-like things taken from the old walls which show in a curious way the laminations of the iron splitting apart under rust. There are in the same case pieces of copper which have stood well, and no doubt that metal would have been used but for the expense. Nevertheless, and recognising the dangers of iron, and it is said taking precautions against it by running the ties in lead, he did wisely in thus binding his cupola and dome, and, as time has shown, rendering it in some measure independent of the settlements of the great supporting piers which have since taken place.

We hear a great deal of rather unconsidered talk about domes without iron ties. Domes of any size require very large abutments to be stable without such ties, and though we may put sufficient abutment when the cupola rises from the ground, as in the Pantheon, we can rarely do so when it is raised on a drum, as in the Duomo at Florence or in St. Peter's at Rome.

I hope when time permits to complete the drawing showing the interesting construction of the cone at its base where it unites with the inner brick dome. I do not find anywhere any sketches or drawings showing this clearly, and I have sufficient measurements to do so. I also hope to make a mathematical investigation, but that should be presented to you in a written communication.

DISCUSSION ON THE FOREGOING PAPERS.

Mr. LEONARD STOKES, *Vice-President*, in the Chair.

Mr. JOHN SLATER [F.] said he had been asked to move a vote of thanks to Mr. Macartney and to Mr. Dunn for their very interesting Papers. The question of the stability of St. Paul's appealed not only to every Londoner but to every Englishman, because St. Paul's was a national building, and had so often been compared with St. Peter's as regards rapidity of construction and various other points. Mr. Macartney's Paper had been very exhaustive with regard to the early settlements in the structure, and it seemed now fairly clear that the main settlements had been on the side they would have expected them to be, viz. on the slope towards the river or to Fleet Street; but the Meeting would have been glad if Mr. Macartney had told them a little more as to the result his investigations had shown to have occurred from the construction of the Tube railway. It was mentioned in the Paper that Mr. Penrose reported that he was very fearful of the results if this railway should be constructed, but he did not gather from Mr. Macartney that any of the effects Mr. Penrose feared had really occurred. This was a subject of very great interest to all architects. He himself had been consulted some two or three years ago as to the safety of Bow Church and various other buildings on the line of

the Central London Railway, and he had a theory which might or might not be correct. It appeared to him that the construction of a tube railway was of such a nature that it was almost impossible to avoid a slight displacement of the strata through which the tube was driven between the time of the first driving of the shield and the entire filling-up of the space both above and below the tube with very strong liquid cement or fine concrete, which was driven in with considerable pressure. During the interval between the first driving of the shield and the thorough encasing of the tube with concrete, he thought it extremely probable that certain settlements would occur, and there was no doubt whatever that they had occurred. The tower of Bow Church, as most people knew, had tilted over, he believed, some six inches, and just after the construction of the tube railway the opinion was expressed that this settlement, this overhanging, might go on increasing and the safety of the fabric be very seriously endangered. He himself took an opposite view, because, after the construction of the tube and the entire filling-up of the space around it, he thought that the effect of the hollow tube through which the train passed was really no more than if an absolutely solid wedge had been driven through

the strata, and that unless the tube itself collapsed there would be no further displacement of the strata, and no further danger to the structure near which it was carried. The construction of a sewer was not of the same nature as the construction of a tube railway, and, as far as he was able to form an opinion, he thought that the Committee of Experts were perfectly right in urging that the sewer which the County Council proposed to construct should not be constructed in the position contemplated, and all that Mr. Macartney had said confirmed him in that view. With regard to Mr. Dunn's Paper, everyone present must have been charmed with that unique isometrical view of the dome and cupola which had been shown on the screen. It must be an enlightenment to all of them; he for one had never seen such a very striking view of the construction of the dome of St. Paul's. He would conclude by moving a very hearty vote of thanks to Mr. Macartney and Mr. Dunn for their very interesting Papers and illustrations.

MR. R. PHENÉ SPIERS, F.S.A. [F.], in seconding the vote of thanks, said that what struck him in Mr. Macartney's Paper more than anything else was the statement that there were already settlements in Wren's time. If he understood Mr. Macartney aright, there was a settlement of nearly six inches of one of the piers which had had to be made good while the building was going on. That was a most serious fact, and the question presented itself to what extent it might be further increased by the shifting of the soil underneath. A point had struck him in comparison with the great dome of the Pantheon. The Paper read some years ago, and the drawings illustrating it, showed that there was actually no thrust whatever in the lower part of the Pantheon because the whole of the construction was built in horizontal courses in brick—the Roman brick-like tiles. That construction was adopted to avoid any thrust in the lower portion. As regards the upper portion, where there was a series of arches, it occurred to him that Wren had adopted a similar system in the upper portion of the cupola which Mr. Dunn had described. He had very much pleasure in seconding the vote of thanks.

MR. FRANCIS FOX, M.Inst.C.E., said it had been his good fortune to visit the Cathedral both in the company of the late Mr. Penrose and also with Mr. Somers Clarke, so he naturally took very great interest in the building. On the question of the arching of the steps at the western portal Mr. Penrose distinctly told him it was due to the copying of the Parthenon steps. As to the injury to the Cathedral, there was no doubt that a great deal of it was due to the construction of the sewer in 1835, and those massive tie-rods were put in, he believed, at that date. As regards Bow Church, he would not refer to that, because they had done him the honour to invite him to

address the Institute in February next, when he hoped to touch upon that subject; * but he should like to say a word with reference to the tube railway. He thought the diversion of the sewer referred to in the Paper was the right thing to do; but if there had not been another route for it, personally he would not have hesitated to drive that sewer, without the slightest injury to St. Paul's Cathedral or any other building in London. It was only a question of how it was done. He had to superintend with his brother, Sir Douglas Fox, on behalf of the Gresham Committee, the construction of that portion of the Central London Railway which was then being built by the late Sir Benjamin Baker and Mr. Mott up Threadneedle Street. The Gresham Committee were much alarmed lest there should be any damage done to the Royal Exchange and to other buildings. He had an interview with Sir Benjamin, and told him that he did not like the idea of the tunnels being driven under Threadneedle Street so close to the Bank of England and to the Royal Exchange for fear of causing settlement. Sir Benjamin turned to him and said, "I know what you want, you want compressed air. Very well, you shall have it." Hence it was that compressed air was used, and there had not been the slightest movement in the buildings near; if there had been, the frescoes on the walls of the Royal Exchange would have been the first to show that there was settlement. A tube railway could be driven through the clay of London, when it was properly done, without affecting in the slightest degree the buildings above; therefore he wished to dissipate the fear in the minds of many architects that there was danger in the construction of such railways. There was no danger at all if the tube was kept in the London clay, and if the work was done under proper conditions. The diameter of the railway, as compared with St. Paul's, was nothing more than a sort of rat-hole, and no damage could be or need be done to the Cathedral. Some of the photographs shown were very instructive, and somewhat disconcerting. He thought by the proper application of tie-rods and of the grouting machine those difficulties might be very greatly minimised; but when he showed them, as he hoped to do when reading his Paper, the photographs of Winchester Cathedral, he thought they would all be instructed as to what "cracks" meant. Those shown at St. Paul's were displacements and the moving of stones, but as to cracks he would refer them to Winchester. There they had settlements of 2 feet 3 inches, followed by a distortion of the arch above to a further 1 foot 9 inches. The overhang of one of the gables was over four feet, and there were cracks in some places into which,

* Mr. Francis Fox will favour the Institute with a Paper on "Foundations, the Use of Divers, and the Grouting Machine" at the meeting of the 17th February 1908.—Ed.

without exaggeration, one could put one's head. It was a most lamentable state of things, and he thought that public attention had only to be drawn to that most splendid building, that national monument, Winchester Cathedral, to make people rally round the Dean and Chapter and try to save it from ruin. Otherwise the building was doomed; for the stones were disintegrated, the buildings were out of the upright, and a small portion of the vaulting had fallen in one place. If the public would only support the Dean and Chapter they would be able to restore the building that would stand a thousand years without any cause for anxiety.

MR. WM. WOODWARD [F.] said he quite agreed with Mr. Fox that if a tube was properly constructed damage was not likely to arise, but he had been engaged in three or four cases with reference to the construction of a tube and the subsidence which had resulted therefrom, and the engineers had proved conclusively that Mr. Slater was perfectly right when he said that it was not the tube, but it was that filling-in over the tube, about a couple of inches, rapidly as it might be done, which caused subsidence. If Mr. Fox could succeed in driving a tube without that two inches then the tube would be properly constructed and there would be no subsidence.

MR. FRANCIS FOX: That is perfectly true: if the annular space round the tube is not properly filled then you are liable to subsidence, but if you are working under compressed air you have no difficulty about that, because you have ample time to fill it, and you get no subsidence at all.

MR. J. DOUGLASS MATHEWS [F.] said that about thirty-five years ago he visited St. Paul's Cathedral with the Architectural Association (before Mr. Penrose's time, he thought) and they were shown certain cracks in the south transept. He had been anxious to hear whether any serious settlement had taken place since that time. He was born almost under the shadow of the Cathedral, and he had been there nearly all his life. He therefore knew the place tolerably well, and he had always watched it with great care. He had observed that the south transept had moved to some extent, but from the photographs he had seen that evening there seemed no reason to fear anything serious happening, because much of the settlement that had taken place had probably occurred soon after the Cathedral was built. With reference to the foundations, and also the earth on which it was built, it had fallen to his lot to erect several large buildings south of the Cathedral—one of them very near indeed, in Godliman Street, which was excavated about twenty feet below the street. They were told there was danger in connection with the foundations of the Cathedral, and it led to a consultation. He could only say that both there and in Queen Victoria Street, and in two or three other places, they found a splendid bed of sand which

was very firm; and if there had been any kind of subsidence or any looseness in the sand they should have come across it. In Upper Thames Street they got a very different state of things. About three years ago there were borings taken between Thames Street and the river, and the top soil—what is called the pot earth—varied in those borings from about seven feet up to twenty feet. Below that there was a kind of river-mud, and below that, again, there was a considerable quantity of sand and ballast, so that there was a depth at high water of from thirty-two to forty feet before the solid clay was reached. As far, however, as the Cathedral was concerned, he had never found anything to account for any subsidence. There was something said at the time observations were being made that the river in high tides loosened a great deal of the sand. All he could say was that he had not come across that; and he did not think that any rising of the river would at all affect St. Paul's. He did not know what the levels were, but he should think that from St. Paul's Churchyard to Thames Street the difference would be from thirty to forty feet, and it was not at all probable that any overflow from the river would affect the foundations on which St. Paul's stands.

MR. J. J. BURNET, A.R.S.A. [F.], in supporting the vote of thanks, said that the photographs shown by Mr. Macartney had interested him very much, and he should like Mr. Macartney to tell them whether he had any records of structural alterations being carried out on that design by Sir Christopher Wren. He asked this because one or two of the arched domes struck him as essentially weak, and, so far as one could judge by the general merits of the design, these were not likely to be the original design of such an architect as Sir Christopher Wren. He was particularly interested in Mr. Dunn's drawing their attention to the really scientific part of the dome, and particularly in his drawings, which were of a kind one did not often see in this country, and he looked forward with the very greatest interest to his further remarks upon it. He should also like to know if Mr. Macartney had discovered the general system under which the iron bands were put round the towers. Was there evidence of each pier having been bound with a desire to prevent it splitting, or was it furthermore attached by another circular band? Was each pier bound, and then each binding attached, so that the eight piers were unified to resist the pressure of the dome?

THE CHAIRMAN, on rising, stated that a letter had been received from Mr. Belcher saying that he hoped his absence from the meeting would not be taken as evidence that he had no interest in Mr. Macartney's Paper; on the contrary he took the greatest interest in it, and it was only his doctor's orders which prevented him coming there that evening. They were all aware, continued the Chairman, that Mr. Belcher did not

enjoy the most robust health, and they could readily understand that he could not venture out in the present state of the weather; he was sure Mr. Macartney and Mr. Dunn would excuse his not being present and taking part in the discussion. They had heard two most interesting Papers and had all no doubt come to the conclusion, and might rest content, that St. Paul's Cathedral in the hands of Mr. Macartney was perfectly safe. An enthusiast such as he was not likely to let things go from bad to worse without letting them know. He, the speaker, was bound to confess that the cracks they had seen on the screen were very much less than he expected to see. He rather anticipated cracks of the nature which Mr. Fox described into which one could put one's head, but they could hardly get their finger into any of the cracks shown. He had occasionally seen cracks of that kind on other buildings; yet a little pointing and discreet disguising made the building, he hoped, quite secure! He had been very much interested in what Mr. Dunn said about the rings in the cone. He (the speaker) had been brought up in the theory that there was no thrust in a dome, that there was a series of rings self-contained, and that they could go on piling up those rings as long as they liked, and there would be no thrust. In India, he believed, and other Oriental countries domes were built without centering: a pole of the required radius was placed in the middle, and that formed a movable centre; bricks were built up all round, and eventually the dome was formed. He had always understood that there was no thrust. He hoped that Mr. Dunn, when he gave his further notes on the construction of the dome of St. Paul's, would reconsider the question of whether or not there was any thrust in a dome, more especially in a conical dome. He understood that there were seven ties round the conical dome; no doubt these ties were intended to help to keep the thing together, but he ventured to think it would have stood equally well without them.

The vote of thanks was then put and carried unanimously.

Mr. MERVYN MACARTNEY, in responding, referred to the question of the tube railway and subsidence. He did not think they had discovered any subsidence due to the tube railway at present. The main point of Mr. Penrose's objection was to the station being placed where it was proposed to be placed in Cheapside, near the north-east angle of the Cathedral. The stations, he believed, were far more dangerous to the surrounding buildings than the tube; they formed in some cases something more or less in the nature of drains. Mr. Penrose opposed the station being placed there, and it was moved to Newgate Street. All these questions of drainage, however, were matters of time. From his experience gravel and clay took a long time to be drained, and when a tube was run 70 or 80 feet down it took a very long

time before that would affect a building situated as St. Paul's would be something like 300 feet away from the tube. It might be forty or fifty years before it had any effect. At present, however, he had no data to give upon the point. Mr. Fox had said he would drive a tube anywhere through London clay. He (the speaker) had not had the experience of Mr. Fox; he had only heard the remarks of people who were, he thought, competent to form an opinion—not engineers—and their opinion was that they might pump in as much liquid grout as they liked round the tube and in the London clay, but a large portion of it would disperse, and they would have round the tube a space which might form a drain—he did not say everywhere, but in certain localities. Another point, it was extremely important to exercise efficient supervision over this question of the grouting. Who was going to do it? They could not have the architect put down there under forced pressure, and he did not know who was going to take the responsibility. As regards the arches to the windows referred to by Mr. Burnet, he had to confess that those round by the dome were very poor, but he had no record at all as to whether they were put in subsequently or not. He was rather inclined to take the view that the voussoirs had been splayed since Wren's time.

Mr. BURNET: The clerestory lights are nearly on the line of the thrust of the dome; in one of your photographs there is a haunched dome with a very thin arch; the haunched dome looks in fair proportion for the external of the arched dome, but these haunched domes seem to me to have been cut away as if the light had been cut up.

Mr. MERVYN MACARTNEY: I do not know if that is the case; we have no record of it at all, but it goes all the way round alike.—As regards the question of the piers being braced up with iron tie-rods, Mr. Macartney said he did not think they were subject to that; there were tie-rods from the south portico, at the end of the south transept, running back almost to the dome, but he did not think they were braced round the piers in any way. It was only the south portico and the south front. These piers were added to by Mr. Somers Clarke on the level of the cornice, and they were not visible now from inside.

Mr. WM. DUNN said they all knew that the impressions one got in one's earliest youth were quite the foremost and most lasting; he would therefore, in the few minutes left him, not attempt to remove those Mr. Stokes had received in his young days. As regards another matter referred to in the discussion, Mr. Fox, the eminent engineer who had favoured them with his presence that evening, surmised that someone had put in the rings which he had shown them after the building was up. That was not the case; they were shown upon the original drawings prepared by Wren, or under his directions, which Mr. Macartney had put upon the screen.



9, CONDUIT STREET, LONDON, W., 23rd November 1907.

CHRONICLE.

The President.

Mr. Leonard Stokes, *Vice-President*, on taking the Chair at the General Meeting last Monday, announced that the President had been summoned abroad on business.

Mr. Macartney's Paper on St. Paul's.

Mr. Macartney's Paper on St. Paul's Cathedral has aroused considerable interest not only within but outside architectural circles. St. Paul's, there is no doubt, has as powerful a hold on the hearts of the British people as the Campanile of St. Mark's had on the affections of the people of Venice. Many of the daily papers, London and provincial, published in full the *précis* of the Paper supplied by the Institute, and the gravest concern has been expressed at the mere possibility of disaster to the building. The *Globe* on Tuesday, in an admirable leading article, frankly confesses its inability to comment upon the matter except as it presents itself to the uninstructed mind, and taking for text the following passage from Mr. Macartney's Paper, "Interference with the subsoil was clearly not contemplated by Wren, and without it they might even now reduce the Cathedral's danger to a minimum," it sums up the situation as follows:—

Put in slightly different terms, this is a confession by a most competent authority, who himself is responsible for the fabric of the Cathedral, that that building is in danger, and that any further tampering with the subsoil may render that danger acute. With the ground left in its present state he is prepared to guarantee the stability of the western towers and of the portico which depends on them, but by this condition they stand or fall. And the warning is the more impressive that it is delivered with complete absence of sensationalism. It is something to feel assured that the guardians of what is in some respects the grandest of our national possessions, of a building which year by year is becoming more and more associated with the life of the metropolis, of the kingdom, and of the Empire, are fully alive to the realities of the situation. Forewarned is forearmed, and they are on the *qui vive* for any utilitarian scheme or act of vandalism which may impair the safety of their sacred charge. But it is necessary that they should have at their backs a mass

of well-informed public opinion, and that not only the learned societies but the man in the street should be up in arms to resist any proposal and any commercial undertaking which should threaten, however remotely, to bring ruin and destruction to "the dome with the golden cross." The Press have played an active and a useful part in resisting the latest enterprise of modern ingenuity which it was proposed to exercise at the expense of the Cathedral, and the wider the publicity that is given to Mr. Mervyn Macartney's Paper the better.

The County Hall Competition.

At the meeting of the London County Council last Tuesday it was reported that, as the result of the voting of the twenty-three competitors in the final stage for the designs for the new County Hall, Sir Aston Webb, R.A., had been elected to act as the third Assessor. Sir Aston, it is understood, has accepted the position. The L.C.C. Establishment Committee have recommended that the Medical Examination Hall on the Embankment shall be rented for five weeks for accommodating the designs submitted in the final competition. The assessing is expected to occupy three or four weeks. The latest date for sending in designs is 30th December next. The Establishment Committee suggest that members of the L.C.C. should have the opportunity on two or three days of viewing the designs, and that the public should be allowed to inspect them during a subsequent week.

Winchester Cathedral.

The King has sent the following letter to the Bishop of Winchester on the subject of Winchester Cathedral:

Windsor Castle, 14th Nov. 1907.

"DEAR LORD BISHOP,—The King has read with interest, but with deep regret, the letter you have written to Lord Knollys regarding the serious danger still threatening the safety of Winchester Cathedral.

"His Majesty commands me to assure you how sincerely he trusts that the appeal now being made by the Dean and Chapter of Winchester to save this great national monument may meet with a hearty and liberal response from the nation, and that, even large as the sum required is to ensure the safety of the sacred building, it may soon be collected.

"By the King's command I have the pleasure to forward you a cheque for 250 guineas which His Majesty wishes added as a donation from himself towards the "Cathedral Fabric Fund," the success of which fund, let me again assure you, His Majesty most anxiously looks forward to.—I remain, dear Lord Bishop, yours faithfully,

"D. M. PROBYN, General Keeper of
H.M. Privy Purse."

It is understood that the Ecclesiastical Commissioners have increased their contribution of £2,000 to £5,000.

Mr. Francis Fox, M.Inst.C.E., in the course of the discussion on Mr. Macartney's Paper last Monday, referred to Winchester Cathedral as being in a most lamentable condition. The stones are disintegrated, the buildings out of the upright, and a small portion of the vaulting has fallen. Settlements of 2 feet 3 inches have caused the distortion of the arch above to a further 1 foot 9 inches. The overhang of one of the gables is over 4 feet, and there are cracks in some places into which, without exaggeration, one could put one's head. Mr. Fox earnestly supported the Dean and Chapter's appeal for funds, and expressed the conviction that the building was doomed, unless its thorough reparation could be taken immediately in hand.

Exhibition of Architectural Sketches.

An Exhibition of Pen-and-Ink Sketches in Holland, Brittany, &c., by Mr. T. Raffles Davison [*H.A.*] is announced to be held at the Modern Gallery, 61 New Bond Street, W., from the 29th November to the 12th December. Mr. Raffles Davison's contributions to art are well known from the illustrations in the *British Architect* and elsewhere, and this exhibition of the originals of his delightful and effective sketches will be looked for with pleasurable anticipation by numerous admirers of his masterly work. It is understood that Mr. Walter Crane will contribute a preface to the Exhibition Catalogue.

The late M. Emile Trélat [*Hon. Corr. M.*].

At the General Meeting last Monday the decease was announced of M. Emile Trélat, founder and director of the *Ecole Spéciale d'Architecture* at Paris, and Hon. Corresponding Member of the Institute since 1884. The Hon. Secretary, Mr. Alexander Graham, F.S.A., in making the announcement, said that M. Trélat was a very distinguished man, and he had had a great career. His life had been devoted unsparingly to the cause of the higher education of architects, and his influence had been considerable in the promotion of architecture. The Institute had been proud to number him among their Corresponding Members. His great knowledge and experience had ever been at their service in correspondence on various matters connected with their art. Mr. Graham concluded by moving that the regrets of the Institute for the loss they had sustained be recorded on the Minutes of the Meeting, and that a letter be addressed on their behalf to the family of M. Trélat sympathising with them in their bereavement.

An interesting account of M. Trélat's work in connection with the artistic and technical training of architects and the foundation of the *Ecole Spéciale d'Architecture* will be found in one of the Papers by the late Mr. Arthur Cates on "The Higher Education of Architects" [*JOURNAL*, 6th April 1901]. M. Trélat made important contributions to architectural literature. Some

of his works are in the Institute Library, mostly copies presented by the author.

The late George Frederick Bodley.

Mr. Henry Vaughan, the late Mr. Bodley's partner in respect of Washington Cathedral, communicates to the Institute through Mr. Edward Warren [*F.*], the following resolution passed by the Boston Society of Architects on the 22nd October:—

"The Boston Society of Architects has learned with the most profound regret of the death of Mr. George F. Bodley.

"Earnest, scholarly, efficient, the recognised leader in the rehabilitation of Gothic as a living style, his influence on the profession of architecture has always been exerted in favour of the highest standards and the most noble accomplishments.

"Associated with American architects in the creation of two great cathedrals, his death involves a notable loss to the Church and to American architecture, while the profession throughout the world is thereby left the poorer.

"The Boston Society of Architects desires, therefore, to extend through his associate, Mr. Henry Vaughan, to his family and his colleagues in England the expression of their sympathy and their deep regret.

"BOSTON SOCIETY OF ARCHITECTS,
per H. J. CARLSON, Secretary."

Liverpool Cathedral.

The Liverpool Cathedral Committee have passed a vote of condolence with the family of the late Mr. G. F. Bodley, the joint architect of the Cathedral. A resolution was afterwards adopted investing Mr. Gilbert Scott with full power to act for the future in the construction of the Cathedral, but reserving to the committee the right to appoint a joint architect if at any period it became advisable in their opinion to do so.

ARCHITECTURAL REFINEMENTS.

[*Ante*, pp. 17-51.]

1 Hare Court, Temple, E.C.,
15th November 1907.

To the Editor JOURNAL R.I.B.A.—

MR. GOODYEAR—MR. BILSON.

SIR,—Would it not be useful for someone who is in sympathy with the conclusions of Mr. Goodyear to kindly give us a guide to the essential points of his theory? Intensely interested in this I have three times embarked on the long communication printed in the last number of the JOURNAL, but have failed to find my way to the exact issues.

In what cases are the facts he finds in ancient buildings not irregularities, but "refinements"?

In what cases are the latter to be attributed to constructive expedients, and in what to idealist intention? And, again, in these last, how was this idealism maintained through the many centuries and through the many generations of constructors to whom the mediæval churches, as we see them now, have been generally due? A guide to the leading facts upon which Mr. Goodyear establishes his position as to the above questions would be a boon to your readers, I believe, as it would certainly be to me.

I beg to remain yours faithfully,
EDWARD S. PRIOR.

"A Rejoinder" to Mr. Goodyear has been received from Mr. Bilson, and will appear in the next number of the JOURNAL.—Ed.

THE PRESERVATION OF ANCIENT MONUMENTS.

Holyrood Chapel.

The allusion in the Opening Address of our esteemed President to the question of the preservation of the Chapel of Holyrood Palace has brought the subject very prominently before the profession, and induces me to say a word on the very important question of restoration, although the question in this case has, I fear, become academic rather than practical.

This building is exceptionally well preserved. There is, speaking broadly, no difficulty in retaining it for all time, even to its most minute detail. The existing work is substantial, or could be made so without the destruction of any ancient nature, however trivial. It is all there. It is incomprehensible how any influential body of men could prefer a useless ruin, however picturesque, to a completed building with all its ancient features preserved. It is impossible by any temporary construction however practical (and hideous) to afford the same protection from the weather to the existing remains as would be afforded by a worthy roof constructed on the original lines.

In the past it has not been considered necessary, because a building has become ruinous, to allow it to remain so. Nor is it always so considered even in these days. The works now in progress at Selby are a case in point. When the central tower and spire of Chichester fell, steps were immediately and very successfully taken to re-erect it.

Surely we owe it to those who in past years devoted their wealth and energies to the erection of such magnificent buildings as this to preserve them for the uses to which they were originally devoted, and not to look on idly while they crumble away; and, on the other hand, not to render them

unsightly by the introduction of protection or support wholly out of character with the structure itself—such as, not to multiply instances, the wooden shores put up some years ago against one side of The Old Hall, Gainsborough, in itself quite a gem of mediæval domestic architecture, and worthy of better treatment; or the stone flying buttresses which disfigure the church of Minster, Thanet.

Restoration means, or should mean, "preservation." Of course there are restorations and restorations. I shall never forget the impression of grandeur conveyed by Stonehenge as I saw it years ago in its deserted loneliness lit up by the ruddy gold of an autumn sunset; one felt that even to touch a blade of grass would be desecration. It makes one shudder to think of the barbarities to which it has since been subjected.

Each building, however, demands its individual consideration. It by no means follows that a treatment loudly called for at Holyrood would be satisfactory (say) at Glastonbury. The condition of the two buildings is wholly different, but, wherever the state of a building is such that it can be preserved and made available once more for the use for which it was originally designed, the obligation for preservation appears paramount.

JOHN CODD [A.].

MINUTES. II.

At the Second General Meeting (Ordinary) of the Session 1907-08, held Monday, 18th November 1907, at 8 p.m.—Present: Mr. Leonard Stokes, *Vice-President*, in the Chair; 52 Fellows (including 16 members of the Council), 46 Associates (including 2 members of the Council), 1 Hon. Associate, and numerous visitors—the Minutes of the General Meeting held Monday, 4th November, were taken as read and signed as correct.

The Chairman announced that the President was unable to take the Chair, having been called abroad on business.

The Hon. Secretary announced the decease of George Rackstrow Crickmay, *Fellow*, elected 1884.

The Hon. Secretary further announced the decease of Emile Trélat, of Paris, *Hon. Corresponding Member*, and the Meeting resolved that the regrets of the Institute be recorded on the Minutes, and that a letter of sympathy and condolence be sent on behalf of the Institute to the family of the late member.

The following members attending for the first time since their election were formally admitted by the Chairman:—viz., Robert Magill Young, B.A. (Belfast), *Fellow*; Samuel Hurst Seager (Christchurch, N.Z.), *Associate*.

A Paper on THE PRESENT CONDITION OF ST. PAUL'S CATHEDRAL was read by Mr. Mervyn Macartney [F.], Surveyor of the Fabric; and some notes on the Construction of the Dome of St. Paul's were read by Mr. Wm. Dunn [F.].

The subject having been discussed, a vote of thanks was passed by acclamation to the readers of the Papers.

The proceedings then closed, and the Meeting separated at 10 p.m.

